Penerbit Akademia Baru

Journal of Advanced Research Design

Journal homepage:
https://akademiabaru.com/submit/index.php/ard
ISSN: 2289-7984

In Search for Immersive Virtual Reality Experience Model: Methodology Review

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ARTICLE INFO

Article history:
Received 28 June 2025
Received in revised form 23 August 2025
Accepted 23 September 2025
Available online 31 October 2025

Keywords:
Immersive experience; virtual reality; environment; narrative; interaction; model

ABSTRACT

Virtual Reality (VR) as an immersive technology innovation is progressively developed and empirically evaluated using systematic approaches among various disciplines. Numerous corroborated frameworks have been developed to consolidate theoretical knowledge of user performance within the virtual world. Since VR is applied in various interdisciplinary domains, integrative multidimensional models should be progressively developed to ensure VR systems succeed in inducing immersive experience (IX). Hence, this paper examines the conceptualization of recent immersive VR frameworks that best support the VR experience within the context of virtual heritage exploration. The narrative review is conducted based on three objectives: a.) to describe the underlying conceptual knowledge of immersive VR systems, b.) to explain the processing flow of each framework, and c.) to identify components and elements of IX. For that, related frameworks are selected through the process of screening, filtering, and then reviewing through critical reading and synthesizing the content aligned to objectives. The findings summarise the identified concept, processing flow, and IX components and elements. Thus, the study concludes that the conceptual and contextual understandings of VR are crucial to constructing a new integrative immersive VR framework. Nevertheless, this paper unveils vital components and elements of IX from previous studies that could be considered while developing and evaluating VR systems. Therefore, future research is about developing a new integrative IX model for empirically evaluating user performance in historical and cultural-based immersive VR systems.

1. Introduction

The immersive experience (IX) models in the context of virtual reality (VR) applications refers to a structured framework constructed to enhance the user's sense of presence, immersion and engagement within virtual environment [1], [2], [3], [4], [5]. Models are likely required to create standards, principles, or methods that facilitate the design and creation of user engagement,

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https://doi.org/10.37934/ard.146.1.207223

learning, and immersive experiences [6], [7], [8], [9], [10]. In another view, a framework comprises details of technological infrastructure and software components that enable the creation and deployment of user experiences including hardware devices, software platforms, development tools, and interaction methodologies [11], [12], [13], [14]

Immersive technological systems progressively evolve duly to its technological aspects. Those aspects have improved due to advancements in data processing systems in digital technology and the human-computer interaction (HCI) field, driven by the enhancements of Industry 4.0 [15], [16], [17], [18]. VR becomes more immersive medium when supporting with head-mounted display (HMD) and multisensory technology which aims to produce immersion. VR devices provide dynamic interactivity of multisensory input channels and responses, and embodiment preferences which allowing user to interact with and manipulate virtual objects of virtual environment, thus increase the degree of immersion, leads to fully user's immersive experience.

Immersive experience is evaluated based on conceptualised and operationalised immersion dimension. Immersion dimension is conceptualized differently by researchers either as unidimensional or multidimensional concept [19]. It becomes key construct uses to evaluate user's perception on technological features, cognitive and affective responses within virtual environments. Therefore, precisely defining different dimensions of immersion and developing reliable measures for them would contribute to enhancing VR experience outcomes.

Numerous applications produced using immersive VR cover in diverse scientific and educational area. Its adaptability and flexibility which could be tailored to distinct scenarios and intentionally crafted will evoke widely varied outcomes. Therefore, VR is defined as extreme meta-medium [20]. Apart from that, VR technology view from post-phenomenology possess as multi-stable [21] medium because it held several different stabilities in terms of how user can experience it considering individual human, user and environment connection. Additionally, VR applications intended to deliver a specific intervention effect by embodying a real function. Well-structured user subjectivity and virtual environment objectivity could enhance user performance and increase the effectiveness of immersive VR systems. Eventually, a grounded conceptual and operational framework for developing VR systems should be firmly established before the development process is conducted.

Along with that, the narrative review used in this paper entails an in-depth examination of three frameworks related to immersive VR technology. This examination analyses their existing methods, theoretical concepts, process flows, main components, and relevant elements in the context of virtual cultural and historical heritage exploration. Therefore, the review conducted based on few objectives; a.) to describe the underlying conceptual knowledge of immersive VR system, b.) to explain processing flow of each framework, c.) to identify components and elements of immersive experience (IX). The models are; 1.) Immersive Environment-Human Interaction Framework [22], 2.) Conceptual Framework for Immersive Heritage Experience [23], and 3.) Post-phenomenological Conceptual Framework [24].

In this case, the review might explore various methodologies used in the field of VR to achieve immersive experiences, involving a comprehensive review of these methodologies to create an immersive experience model within a VR framework. The aim is to synthesize and present a comprehensive understanding of effective approaches to designing immersive VR experiences.

2. Literature review

As described earlier, VR can be characterized as a multidimensional, meta-medium, and multi-stable technology regarding its immersion dimension, applications, and intervention concepts. Researchers and developers stand in needs for developing integrative framework that elucidate the

relationship among immersive VR system features, user experiences, and the outcomes associated with immersive technology utilization [25], [26], [27], [28], [29]. In the heritage field, digital or virtual heritage involving cultural and historical content is used as a stimulus in VR applications [30], [31], [32], [33], requiring more technological and content considerations while designing immersive virtual environments [34], [35], [36].

The compilation of factors coupled with directions of future research derived from literature review [1], [19], [22], [37], [38] can offer valuable guidance for researchers and developers to conceptualise new constructs capturing distinctive elements of immersive technology usage in order to formulate, evaluate, and validate their hypotheses within the context of immersive technology adoption.

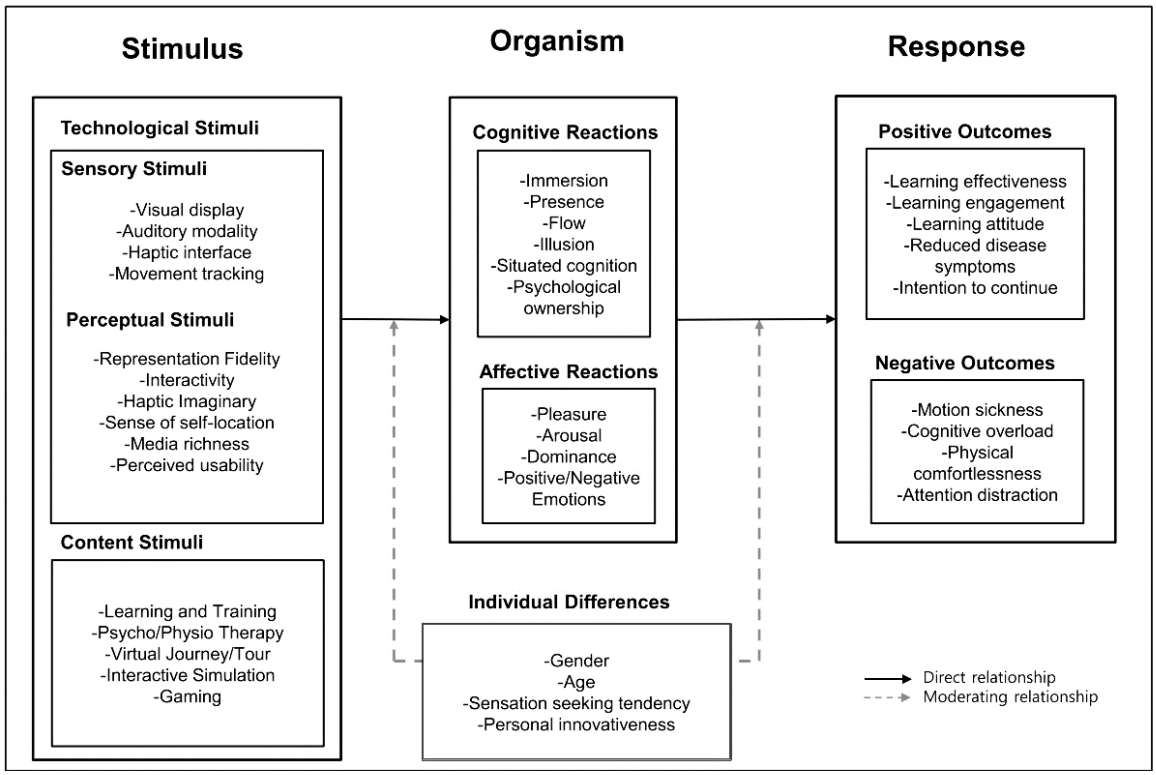

Fig. 1. S-O-R Framework [19]

Following that, Suh & Prophet, (2018)[19] have suggested prospective study on immersive technology in their conceptual framework (Figure 1) which should start with a.) investigate how diverse technological stimuli impact different facets of user performance, particularly within specific contexts, while also prioritizing the development of metrics for the distinctive attributes of immersive technology, b.) define immersion more precisely, explore its interplay with related concepts, and how different dimensions of immersion impact user performance, and c.) investigate how different stimuli, both technological and content-related, influence user experience and performance.

3. Review of immersive VR experience models

The three models are selected based on their similarities in focusing on immersive technologies. These abstracts explore different aspects of VR and immersive experiences. Below is a table (Table 1) summarizing these three main articles, highlighting their common themes and main focus areas

related to immersive technologies and VR. This shows how they share a common theme of exploring immersive technologies and VR in different contexts.

Table 1
Summary of main focus and theme of each study

Study	Main Focus and Theme
Vindenes & Wasson, (2021) [24]	Post-phenomenological framework for understanding VR mediation, focusing on user-environment and human-world relations.
Dogan & Kan, (2020) [23]	Creating immersive experiences at heritage sites with a threefold conceptual framework encompassing phenomenological, narrative, and semantic aspects.
Rubio-Tamayo *et al.,* (2017)[22]	Insight of immersive digital technologies, particularly VR, with emphasis on their potential applications in scientific, educational, artistic, and informational domains, while considering interactive and immersive features.

3.1 Post-phenomenological Conceptual Framework [24]

To gain a deeper understanding of the user experiences resulting from VR interventions, VR should also be evaluated from a post-phenomenological perspective, as it reflects the human-technology-world relationships [21], [24]. The examination of the interaction between humans and technology helps determine which immersion relation is most pertinent to the user experience in VR. The concept of immersion has been viewed as a more dynamic interpretation of Ihde's and Verbeek's human-technology relations [39], [40]. As a consequence, human individuals are drawn towards technology, and conversely, technology is oriented towards them, resulting in what can be described as "reflexive intentionality" [40]. This phenomenon enables humans to cultivate new relationships with themselves through their interactions with technology. The relationships that result from VR technologies mediating experiences explicitly can impact the way humans relate to their world, potentially leading to changes in human behaviour, feelings, and attitudes. In accordance with reflexive intentionality, Vindenes & Wasson, (2021)[24] have emphasised immersion relation in their conceptual framework (Figure 2) that views the user experience in immersive VR as a mediated experience of relations between humans, the world, users, and the environment caused by interaction. They also discussed the interrelations of various aspects of the framework. Understanding the relationships between humans, the world, mediators, users, and the environment is vital for conceptualizing the adoption of VR technology interventions.

Additionally, an enduring human-technology connection serves as the foundation for various other relationships within the virtual realm, but it assumes a distinctive manifestation in the context of VR. The user-environment relation identified based on a human in an embodiment relation with the technology (i.e., the user) in an alterity relation to the technology (i.e., the environment), while the world is in the background. When an individual becomes embodied in VR, they establish an alterity relationship with the virtual environment, directly engaging with the technology within its own system. Consequently, in the embodiment process of a VR Head-Mounted Display (HMD), user simultaneously act through the technology and upon it. This duality allows VR to serve as a medium for both (i) presenting the objectivity of the environment in which users are situated (alterity), and (ii) shaping the users' subjective position and connection with that virtual environment (embodiment). Types of VR user-environment relation are described details in next paragraph.

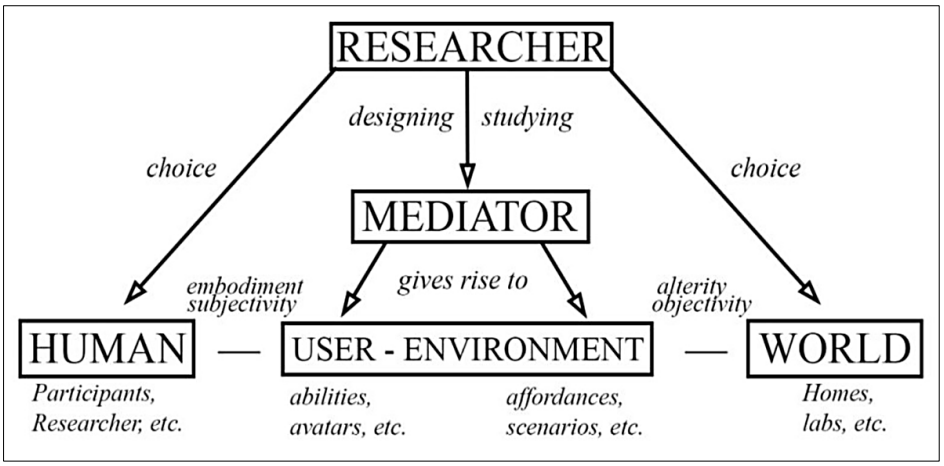

Fig. 2. Post-phenomenological Framework [24]

As we embody various elements of VR technology, including hardware, avatars, and tools, they become integrated into our subjectivity through a transparent embodiment relationship. At the same time, the objectivity of our VR experience, encompassing the environment, virtual actors, and social scenarios, is also influenced by the same VR technology. An opaque alterity relationship is established in which the virtual world commences a background role.

The focus is placed on identifying the constituents, components, and elements involved in immersive VR-mediated experiences, as well as the types of relationships described from post-phenomenological perspectives. This is done to enable researchers and practitioners to better understand the concept of interaction in immersive VR. In fact, the user experience, as mediated in relations constituted between the user and the environment, emphasizes the human subject and the technology experienced as a result of the interaction.

The primary aspect of the framework focuses on human who engage with VR technology, as viewed through the lens of post-phenomenology, which recognizes that technology has diverse potential uses and experiences, even if initially designed for specific purposes. Elements like professional expertise, personal experience, cultural background, and gender influence users' interactions with technology, guided by relational strategies that allow users to approach technology in distinct manners. Additionally, individuals might possess varied hermeneutic strategies that aid them in interpreting a technology's significance from specific viewpoints. It's crucial to acknowledge that while VR applications offer diverse interaction possibilities, they aren't entirely neutral, as all technologies inherently possess a certain orientation. Despite the multitude of potential usage paths, some will prove more dominant and stable than others.

World is the framework's second component revolves around the context in which the mediating technology is employed within the human sphere. Phenomenological perspectives on places and contextual settings underscore the interconnectedness of individuals and their surroundings, where places, encompassing geographical, architectural, and socio-cultural aspects, contribute to shaping behaviour, identity, and emotions. Thus, places can also be considered agents influencing our sense of self. Beyond the individuals involved, the "world" in which the technology is utilized holds equal significance. This world serves as the application's "use-context" and becomes a backdrop for the user's experience, even when immersed in a virtual environment. This concept aligns with the idea of multi-stability in post-phenomenology; technology carries different meanings across various individuals and contexts.

Then, in the context of VR interventions, the mediator typically consists of a virtual environment that provides a first-person perspective to the user. The design of this technology can serve various

purposes, such as therapeutic or training applications, with the objective of fully engaging the individual within the virtual environment. This mediator establishes a user-environment relationship wherein the individual assumes the role of an embodied user, immersed in, and intentionally connected to, the virtual environment, while the physical world remains in the background.

User is the initial component of the mediator pertains to the embodied user, positioned within the simulation while functioning from a specific subjective standpoint. It is essential to differentiate the "user" entity from the human participant; it does not merely represent the subjective standpoint into which the participant is immersed. Instead, it embodies the human participant as a user, implying that the individual is actively engaging with the VR technology, becoming virtually embodied, and forming an intentional relationship with the virtual environment. In this context, the subjectivity of the user can be described as "nested within the individual's subjectivity in the actual world". The mediation of human subjectivity occurs both within the simulation concerning the virtual world (User) and outside the simulation concerning the real world (Human). These technologies enable us to objectify our desired identities and, through embodiment, immerse ourselves in the perspective of these created personas.

Closely associated with the user is the environment, constituting the second sub-component of the mediator. This environment represents the aspect of the VR application that lacks embodiment and thus serves as the alterity to which the embodied user relates. The nature of the environment in terms of the world or setting in which the user is situated, its fundamental operational parameters, and its representational characteristics. For instance, the system may differentiate between objects that can be interacted with and those that are purely decorative or situational, as well as their proximity to the user or distance. It is important to emphasize our (post)phenomenological understanding of the environment. How the environment is comprehended from the situated perspective of the user is more vital, rather than adopting a detached, omniscient viewpoint. It is essential to acknowledge that VR technologies do not induce such immersion that participants completely lose their sense of self or connection to their real-life surroundings. The real world continues to exist as a background relation, and the user's subjectivity remains nested within the subjectivity of the human individual in the actual experiment.

Next, is to identify how interventions in VR create diverse user-environment relationships that, in turn, mediate various interactions between humans and their virtual worlds. The mediation of VR experiences typically involves examining how a specific user-environment relationship depends on the elements related to subjectivity (embodiment) and those associated with objectivity (alterity). By analysing user-environment relationships within VR, it becomes possible to discern the underlying ontological structures that account for observed differences in the overarching embodiment-alterity relationship. As a result, in this study, the analysis primarily focuses on the last two categories, namely, "Subjectivity-Objectivity Inversion" and "Subjectivity-Objectivity Synchronization," as they delineate the innovative relationships that can emerge between the user and the virtual environment in VR.

The first relation is subjectivity-objectivity inversion which describes self-identification from two perspectives; *Self as Other* and *Other as Self*. For *Self as Other,* much like how each individual's unique human perspective inherently carries limitations when perceiving others, the act of self-observation from one's own vantage point also possesses its own inherent constraints. When viewing oneself from one's own perspective, the self tends to be perceived as a complete, self-contained entity, while it remains incapable of achieving a similar comprehensive self-view. Consequently, objectifying the self may offer advantages in terms of attaining altered perspectives and broadened insights.

Whereas for *Other as Self,* it is resulted from human experience, as human will engage in various forms of identification. Both as individuals and as members of specific groups, including socio-

cultural, racial, ethnic, gender, and age groups. Consequently, human self will perceive other groups as distinct from our own, leading to a different perspective on ourselves and our situation compared to how we view others and their circumstances. While this inherent limitation is part of human nature, VR has the capacity to establish a user-environment relationship that transforms what has traditionally been seen as "Other" (objectivity) into "Self" (subjectivity).

The second relation is subjectivity-objectivity synchronization which refers to an effort aimed at establishing concordance between the user's inner experiences and the external world they encounter in VR. This endeavour may involve either representing the user's inner experiences through the external world or influencing the user's inner experiences through the external environment, or a combination of both. While subjectivity-objectivity inversion involves the active adoption of perspective-taking and self-distancing techniques, applications designed for subjectivity-objectivity synchronization actively employ meditative practices like mindfulness. In the realm of VR, the pursuit of unity between subjectivity and objectivity, or self and other, is explicitly approached by blurring boundaries or establishing new relationships between these two aspects. Within these user-environment relationships, users adopt an intentional stance toward the environment, thereby experiencing the environment, and conversely, the environment assumes an intentional relation toward the user and "experiences" the user. This results in an immersion relationship between the user and the environment, leading to reflexive intentionality where the user not only perceives the environment but also gains a new perspective on themselves. The nature of these relationships may tend toward hermeneutic or alterity, depending on the extent to which the user endeavours to interpret or decipher the "message" conveyed by the VR application.

Each user-environment interaction will inherently possess a subjectivity-objectivity configuration subtly distinct from others. As researchers delve into genuine phenomenological accounts, they need to anticipate encountering an increased richness of nuances and complexity in these relationships.

3.2 Conceptual Framework for Immersive Heritage Experience [41]

The concept of (Dogan & Kan, 2020)[41] study is to explore the ways in which heritage sites can be brought to life for visitors through immersive experience within the heritage context. The proposed tripartite conceptual framework flow includes ludic, narrative, and semantic turns or levels (Figure 3). These levels are interconnected and mutually reinforcing, forming a cyclical connection rather than a linear process, thus aims to bridge the gap between the physical and imaginary virtual worlds mediated using VR to make heritage experience is more accessible, visitor-friendly, and memorable immersive experiences.

From a practical view, virtual representation plays a significant role in enhancing knowledge and making it easily accessible to anyone, regardless of their location or time. Visitors play a crucial role as either active or passive participants, engaging both in the creation and consumption of content. In immersive heritage practice, key characteristics involve prioritizing storytelling, focusing on the audience's involvement, utilizing multiple sensory modalities, and being mindful of the environment. In addition, it highlights the significance of incorporating elements such as a strong sense of place, compelling storytelling, and emotional connection to create meaningful, valuable and captivating experiences for visitors.

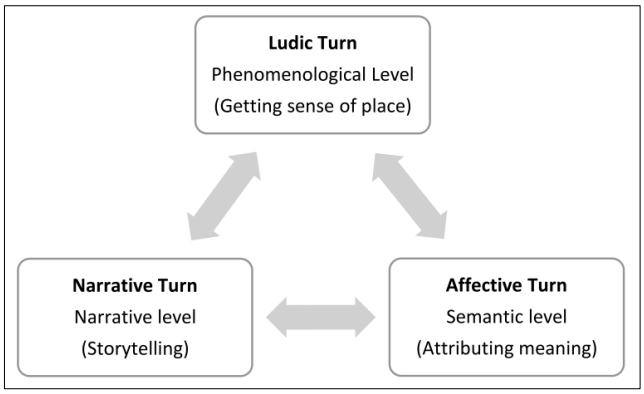

Fig. 3. Conceptual Framework [41]

The study describes through a series of interconnected stages that collectively illuminate the process of immersive heritage experience. The process commences with the Ludic turn, characterized by an analytical exploration of immersive technology from a phenomenological perspective. Central to this perspective is the concept of the "sense of place," which holds profound implications for the immersive experience. Immersive technology possesses the remarkable capacity to blur the boundaries between reality and the virtual domain, drawing individuals into a realm of representation where narratives play a pivotal role in capturing the sensation of being present within this alternate reality.

In this context, phenomenological archaeology sheds light on the interaction between humans and artefacts, portraying it as a form of somatic engagement that leads to knowledge generation. This perspective posits that understanding a past culture necessitates a deep connection with the material world, intertwining the tangible presence of objects with the intangible aspects of cultural heritage, all within the framework of human corporeality [42].

Expand upon this, Tan & Rahaman, (2009)[43] emphasised that the built environment serves as a reflection of society's intentions and norms, symbolizing the essence of its social fabric. Within this context, the notions of co-presence and shared experiences serve as the bedrock for participatory modes of interaction within the social dimension. Dialogic interaction, shaped by the presence and interactions of others, exerts a significant influence on the process of assigning meaning. This intersection between immersive experiences, sense of place, and phenomenological engagement sets the stage for the subsequent narrative turn.

The narrative level or storytelling [44], [45], [46], [47], [48], [49], [50] represents the second phase of this immersive journey. Here, the influence of stories, myths, and metaphors takes centre stage in shaping the overall experience. Narratives, within the context of specific places, perform a unifying function, bridging the gap between fact and fiction, or past and present, by employing myths, fantasies, and imagery to convey meaning. These narratives become instrumental in evoking the sensation of presence, actively engaging visitors through two key elements: imagination and performance. By participating in the act of narrating, individuals are transported away from their immediate surroundings, paving the way for a truly immersive encounter. Narratives also serve as critical tools for contextualizing specific content, transforming it from mere factual information or abstract concepts into potent vehicles for conveying deeper significance.

In particular, narratives and myths, situated within a broader cultural context, transcend the mere recounting of events; they encompass shared meanings subjectively interpreted and perpetually reconstructed. On the other hand, the concept of genius loci refers to the unique character imbued within a place, which can be experienced on a phenomenological level. Within the context of heritage, narratives become intimately entwined with specific sites, accentuating the distinctive

qualities of each heritage location that cannot be transposed to another. Mythologies play a substantial role in eliciting emotions and fostering remembrance by weaving informational elements into narratives.

The final stage of this immersive journey is the process of heritage interpretation, culminating in the construction and conveyance of meaning at the semantic level. Historical places, sites, and monuments transcend their physical attributes to occupy a significant position within the realm of tangible heritage. Visitors, whether actively or passively, play a pivotal role in the meaning-making process as they engage with these elements, locations, and events. Heritage interpretation involves forging connections between tangible and intangible elements, facilitating the exploration of collective memories and nurturing imaginative experiences. Crucially, meaning is not a fixed entity confined to a site; rather, it emerges through a multitude of processes and can vary among individuals who experience the same phenomenon. Semiotic approach, which delves into how meaning is constructed and conveyed through a system of signs.

Additionally, two primary approaches are proposed for creating virtual environments. The first approach involves excluding people, their activities, and relationships from the scene, essentially removing "life" from the virtual space. Instead, it focuses solely on representing the environmental elements such as buildings, terrain, streets, and other inanimate components that form the backdrop for the overall context. This approach directs the viewer's attention to the man-made features situated within a specific setting, devoid of human presence. Consequently, it presents a stripped-down, unadorned reality, albeit lacking a predefined narrative, which may encourage viewers to engage their own imaginations.

Conversely, the second approach stands in stark contrast to the first. It aims to craft immersive content with meticulous attention to detail, including the inclusion of people, the social interactions they engage in, the daily routines within a city, and the interplay among these various elements. This approach may also involve recreating scenes from well-known mythical or historical stories to envelop the viewer. The second approach offers a highly immersive experience that can be truly impressive. However, it introduces a multitude of distractions by delving into intricate interactions. Furthermore, it restricts the viewer's freedom of imagination, as they are compelled to live an experience already predefined for them. Visitor preferences in this regard remain subjective and shaped by cognitive expectations, making it challenging to ascertain a definitive preference.

Immersive experiences gain depth and significance through the potent tool of storytelling, which fills knowledge gaps and breathes life into the past. Emotional resonance and human connection hold equal importance alongside the acquisition of factual information. The concept of 'emotive storytelling' emerges as a potential mechanism for engaging visitors, invoking emotions, fostering connections with others, and enhancing their understanding, imagination, and overall experience. Instead of relying solely on linear narratives and representations, a comprehensive framework should encompass elements such as visualization, sensory engagement, active participation, and cultural learning.

In this burgeoning field of immersive heritage experiences, the interplay between the sense of place (physical vs. virtual), narratives (content vs. context), and meaning (interpretation vs. action) becomes a focal point of exploration. This holistic approach unveils the vast potential of immersive heritage experiences in fostering meaningful relationships with and appreciation for heritage sites, all while bridging the gap between the physical and imaginary realms. Through these immersive experiences, visitors are offered a sensorial journey within the virtual environment, prompting them to reflect on their real-life experiences, attribute significance to the remnants of the past, and understand its enduring relevance.

3.3 Immersive Environment-Human Interaction Framework [22]

Prior studies on VR interaction investigated user experience within various immersive environment settings [4], [20], [21]. In environment-human interaction context, immersive experience also influenced by the user's cognition and proprioception concept. Rubio-Tamayo *et al.,* (2017)[22] developed an Immersive Environment-Human Interaction framework that draws from communication theory. Processing flow of the model elucidates the intricate relationships among elements or factors within immersive environments, features of technological interaction, and the user's proprioceptive feedback which also related to the Artificial, Simulated and Alternate or ASA reality, a wider concept used to describe a reality being artificial (computer generated), simulated (not integrated in the physical world) and alternate (separated from physical world). The technical interactions occur within the components of the immersive VR stimulus, involving both the human participant and the immersive environment itself (as illustrated in Figure 4).

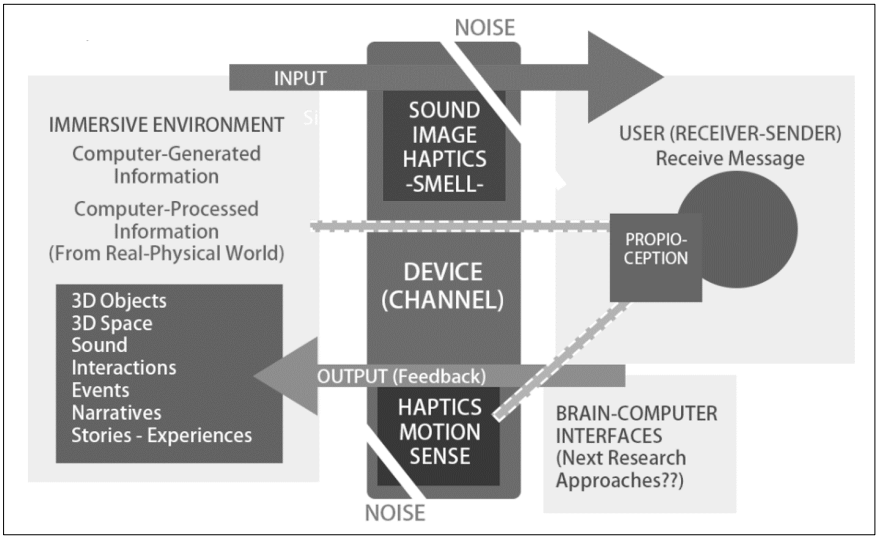

Fig. 4. Immersive Environment-Human Interaction Framework [22]

This model constructed aims to enhance understanding of user-information interaction in multifaceted ways. It started by categorizing and segmenting aspects related to VR through systematic literature review. It becomes imperative to establish well-defined categories that facilitate a deeper understanding of the intricacies of this emerging medium, thus enabling creative and scholarly explorations. Besides, VR is a technology that need insights adaption and integration among interdisciplinary research fields namely; interaction design, human-computer interaction, user experience, cognitive sciences, neuroscience and others to foster interactions and imaginative experiences. Various factors contributed to the delineation of this medium and its evolution, closely intertwined with technological advancements also identified and comprised in the model.

VR and 3D immersive environments constitute media with virtually boundless capacities for ideation representation and interactive engagement. It is imperative to embark on the development and establishment of novel symbolic, narrative, and representational paradigms that facilitate seamless integration within these mediums. This entails pioneering endeavors in the construction of innovative symbolic frameworks and the formulation of models that harmoniously amalgamate the interactive and immersive potential inherent in this technology. In this case, such advancements are necessitated to address the intricate representation demands encompassing a wide array of scientific knowledge and dissemination facets, encompassing domains like color theory, algorithmic principles,

abstract concepts within quantum mechanics, chemical formulas, and the entire spectrum of conceivable scientific disciplines.

Furthermore, narrative and storytelling hold a pivotal significance within the realm of VR, necessitating developers to embark on a quest for fresh narratives that resonate with this medium. They are compelled to push the boundaries, delving into uncharted territories to craft new immersive worlds and convey novel concepts. The evolution of narrative and storytelling has emerged as a crucial factor influencing the VR experience. VR has distinctly cultivated its unique narrative discourse and lexicon, which finds its most prominent applications within the domain of video games. Consequently, the expressive potential inherent in VR has catalysed the exploration of diverse genres within the video game landscape.

In addition, haptic, auditory, olfactory, and related technologies should be harnessed as instruments aimed at enhancing immersion. Haptics effectively used should improve the realism of the immersive experience. In fact, an ultrasonic haptic interface also produced by VR. These experiences should not only strive to present an alternate reality but also aim to amplify users' engagement with the physical world, thereby enriching their overall experiential encounter. The design of new VR experience evolves from those features, integrating interactive narratives or various senses.

Next, the exploration of technologies like brain-computer interfaces, are poised to represent the next phase in the progression of discipline-specific interactions, such as user experience or interaction design, alongside the broader VR field. The notion of interfacing with the human brain within the context of a virtual environment presents itself as a natural evolutionary step in the landscape of VR. At present, technological advancements are actively exploring these domains, as exemplified by the emergence of state-of-the-art brain-computer interfaces tailored for VR applications, such as the 'Neurable' platform.

As conclusion, VR systems development encompasses adaption and integration among interdisciplinary fields namely; interaction design, human-computer interaction, user experience, cognitive sciences, neuroscience and others. To foster imaginative experiences, developers should devise immersive environments, VR device channels, narrative and storytelling and brain-computer interfaces contingent on technological feasibility. In the forthcoming future, these experiences are expected to play a pivotal role in advancing the domains of VR and Artificial, Simulated, and Alternate (ASA) reality, among others.

4. Findings and discussion

This review identified the components, factors, elements or variables data from the identified studies, their theoretical concept, flow of process, main components and related elements of IVR technology as lists in Table 5.

Table 5
The MR on the previous framework of IX

Model	Concept	Processing Flow	Components	IX elements
Vindenes & Wasson, (2021)[24]	Relationships between human, user, environment and world, and VR as mediator	Subjectivity and objectivity of user-environment relation for mediation a. Subjectivity-objectivity inversion	Human World	Personality, gender, socio-economic status interests and motivations, involvements, previous technology experience Geographically, architecturally, or socio-culturally, or situational context

	from post-phenomenological dimension.	b. Subjectivity-objectivity synchronization	Mediator	First person POV, goal, user, environment
			User	Embodiment (body one, avatar), subjective position, subjectivity (relation to actual world)
			Environment	Acted upon, or that which acts upon the user, interactable or decorative, proximity or distance, social actors, 3D object, events/scenario, narrative, etc.
			Interactions	Harmony, mindfulness, feeling of union, reflection, and relaxation
Dogan & Kan, (2020) [23]	Cyclical interconnection between threefold levels: a) phenomeno-logical, b) narrative, and c) semantic of IX.	Immersive heritage experiences, by intertwining storytelling, bodily engagement, and sensory perception, cultivate profound connections with heritage sites, enhancing comprehension and appreciation while bridging the physical and imaginary realms.	Ludic or phenomenology,	Specific, special, accurate, unique, memorable place, sense of real, original location, space-time relation, physical space, corporeality and bodily orientation, embodiment, social practice/world (somatic mode of attention), somatic engagement (interaction with artefacts and places), dialogic interaction.
			Narrative (storytelling), and	Semiotic presentation of a series of events (text with temporal flow), Placed-based narratives; fact and fiction, past and present through myths (archetypal symbols), fantasies, and images and meaning, site- specific, accented on the unique qualities of a particular heritage site, which
			Affective or semantic.	Meaning, historic places, sites and/or monuments, linking tangible and intangible aspects, collective memories, experience, active participation/ interaction and stewardship, system of signs, semiotic or textual meaning structures, spectacle and sensation dominates value, momentary revelations as a “transformative recognition”, logic, co-presence, interrelationship of individual buildings, absence of a story and immersive content with the most possible accuracy.
Rubio-Tamayo *et al.,* (2017)[22]	Factors related to design of environments, experiences and stories in VR	The interaction structure of interplay between immersive environment which transmits input (computer-generated and processed information) through device channels to	Storytelling-narrative dimension:	
			a. Narrative	Real-world events and elements
			b. Storytelling	Dramatic approach
			Interactivity:	

	user, thus user responses (feedback) as output to immersive environment.	a. HCI	Interactive processes between users, digital information and environment
		b. Interaction design	Design of interfaces and digital objects
		c. User experience	Natural user interface and interactive process
		Representation	Communicate and develop its own dynamics (means, idea and concept)
		Gameplay	Integrate research into game and play possibilities.
		Technological Evolution-Mechanics	Same rate that computer graphics technology and processors

Vindenes & Wasson [24] emphasize immersive VR stands as a highly adaptable medium for interventions due to its capacity to construct virtual environments radically different from reality. To better comprehend the underlying experiences in these effective interventions, their framework indicates the user's experience in immersive VR as contingent upon relationships formed between the user and the virtual environment. The interaction between human subject and mediated experience is confirmed as the outcomes. While the dynamic relations established between the user and the environment shaped the user experience. They argue that their perspective offers a more pertinent way to grasp the user experience essential to VR's potential to "transform the self," as it specifically focuses on how the human subject is mediated within the user-environment relationship. They have demonstrated the applicability of the framework by analysing various VR interventions, showcasing diverse user-environment relations characterized by distinct ontological structures.

Dogan & Kan [23] study delves into the significance of heritage sites as repositories of historical remnants and modes of representation that come alive through immersive experience. This necessitates a comprehensive framework encompassing visualization, sensory engagement, active participation [51], and cultural learning [52], transcending traditional linear narratives and representations. They based the study on Rahaman [53] perspective advocates for phenomenological models of perception, highlighting the importance of embodied experiences in knowledge generation, contrasting with behaviourist learning models rooted in physical processes and knowledge transfer. A pivotal element in this model is the "sense of place," enabling visitors to immerse themselves in the context and engage in a deeper experiential connection. Visitor presence is influenced by co-presence with others, drawing on social values and narratives, thereby contributing to the formation of collective memory.

Reconstructions and simulations [54] are viewed as societal constructs and expressions of collective cognitive backgrounds, aiding in attributing significance to heritage sites. In summary, the article sheds light on the burgeoning field of immersive heritage experiences, addressing the interplay between physical and virtual realms, content and context in narratives, and interpretation versus action. The proposed tripartite conceptual framework positions immersive heritage experiences at the convergence of storytelling, bodily involvement, and sensory perception. Through this approach, immersive heritage experiences foster meaningful connections with heritage sites, enriching our understanding and appreciation by bridging the gap between physical and imaginary domains. Ultimately, these experiences offer a sensory encounter with heritage, enabling the past's

presence in a virtual environment and stimulating real-life experiences by shaping perceptions and attributing meaning to what endures and why it holds significance.

Rubio-Tamayo *et al.,* (2017)[22] concluded that VR is not just a collection of technological advancements but also a concept. Models developed show established connections with cutting-edge concepts in various fields, including user experience (UX) and interaction design. This conceptual framework has the potential to serve as a valuable resource for researchers and developers, thus facilitating in the novel experience's creation and innovative expressive frameworks. In fact, it could be applied across diverse scientific research areas and educational contexts.

5. Conclusions

This study has met the research objectives by clarifying the conceptual knowledge and process flow of three main models: 1.) Post-phenomenological Conceptual Framework [24], 2.) Conceptual Framework for Immersive Heritage Experience [23] 3.) Immersive Environment-Human Interaction Framework [22] which are intended to provide more integrated conceptual views of immersive VR experiences. Additionally, the final objective involves a deeper study that investigates the components and elements of IX.

Specifically, the Vindenes & Wasson (2021)[24] model provides a foundational overview of technological relationships, namely subjectivity-objectivity inversion and subjectivity-objectivity synchronization, among the main external VR constituents: human, world, mediator (VR), user, and environment. Meanwhile, Dogan & Kan, (2020)[23] provide insights into how to convey cultural and historical meanings within virtual environments through the cyclical interconnection of three levels: a) phenomenological, b) narrative, and c) semantic IX. Lastly, Rubio-Tamayo *et al.,* (2017)[22] specifically address the interplay between factors related to the concept of ASA reality, a broader construct denoting an artificial, computer-generated, simulated, and distinct reality detached from the physical world. The symbolic and abstract representation, narrative and storytelling, connection between immersive environments and the human sensory apparatus, comprehension of human sensory mechanisms, and development of user interfaces like brain-computer interfaces hold the potential to significantly enhance the efficacy of immersive experiences and VR environments.

VR and immersive environments play a pivotal role in short-term applications across diverse research domains. The conceptual development of VR technology enables the exploration of knowledge about human-technology interaction, interaction design, virtual environment design, and IX with new possibilities in the field of reality technology and across interdisciplinary fields. Thus, defining IX concepts, components and elements could guide researchers in conducting current research.

Nevertheless, more theoretical studies and the development of frameworks are needed to expand and verify this complex mediation medium. This study makes several key contributions to academia. First, the studies on integrative immersive VR technology frameworks are still limited. Therefore, this review can help researchers understand the state of immersive VR technology research in terms of theoretical and methodological approaches, research themes, and contexts. Secondly, based on the findings, researchers can develop new models that explain the interplay between user experiences, immersive system features, and the outcomes of using immersive technology in various fields.

Acknowledgement

This research was funded by the Ministry of Higher Education, Malaysia (MOHE).

References

[1] M. Won *et al.*, "Diverse approaches to learning with immersive Virtual Reality identified from a systematic review," *Comput Educ*, vol. 195, Apr. 2023, doi: 10.1016/j.compedu.2022.104701.
[2] V. K. Ojomoh, F. A. Phang, and N. D. Nawi, "The Effect of the Virtual Laboratory Method on the Conceptual Understanding of Thermal Physics among Undergraduates," 2024.
[3] M. Alivizatou, "Digital Intangible Heritage: Inventories, Virtual Learning and Participation," *Heritage and Society*, vol. 12, no. 2–3, pp. 116–135, 2019, doi: 10.1080/2159032X.2021.1883950.
[4] E. Champion, I. Bishop, and B. Dave, "The Palenque project: Evaluating interaction in an online virtual archaeology site," *Virtual Real*, vol. 16, no. 2, pp. 121–139, Jun. 2012, doi: 10.1007/s10055-011-0191-0.
[5] G. Drettakis, M. Roussou, A. Reche, and N. Tsingos, "Design and evaluation of a real-world virtual environment for architecture and urban planning," *Presence: Teleoperators and Virtual Environments*, vol. 16, no. 3, pp. 318–332, Jun. 2007, doi: 10.1162/pres.16.3.318.
[6] R. Mohamed, M. Zaid Mamat, A. R. Salleh, and A. A. Razak, "Using GeoGebra with Van Hiele's Model in Geometry Classroom: An Experience with Prospective Teacher," *Semarak International Journal of STEM Education 1, Issue*, vol. 1, pp. 1–19, 2024.
[7] Y. K. Lee, N. M. Zaid, and Z. Tasir, "Developing Synchronous Online Teaching Practices through Emotion Contagion Theory using ADDIE," *Semarak International Journal of Innovation in Learning and Education*, vol. 1, pp. 12–23, 2024.
[8] R. Yusri, A. Mohd Yusof, and A. Sharina, "A Proposed Integration Model of Project Based Learning and Simulation to Improve the Learning Quality," 2024.
[9] H. Lee, "A Conceptual Model of Immersive Experience in Extended Reality", doi: 10.31234/osf.io/sefkh.
[10] F. Hishamuddin *et al.*, "Empowering Leaders: A Work in Progress on Promoting Leadership Roles in Online Learning through Project-Based Learning (PBL)," *Semarak International Journal of Innovation in Learning and Education*, vol. 2, pp. 65–73, 2024.
[11] N. Anisa, I. Gani, and H. Habil, "Evaluating the Technical Quality and Pedagogical Affordances of an English Language Learning (ELL) Website using a Methodological Framework," 2023.
[12] A. M. Minalla, Z. Yamani Zakaria, and F. A. Phang, "Developing Theoretical Framework for Evaluation of Engineering Education in Sub-Saharan African Countries," 2024.
[13] A. Narayanasamy, A. Norma, and M. Jaafar, "Beyond Traditional Teaching: A Conceptual Framework for the Transformation of Blended Learning towards Reading Skills Through the I-Saboba Module in Preschools," 2024.
[14] B. Hairiel Abd Rahim, L. Ngan Ping, N. Liyana Izdihar Nor Azman, and F. Shazleen Shaharudin, "Improving Malay Traditional Joget Dance Technique Through Vygotsky Framework among Female Secondary School Dancers in Ampang, Selangor: The participatory Action Research."
[15] N. Ramli and M. Ekram Al Hafis Hashim, "Interactive AR Textbook Application For 3M Orang Asli Students in Primary School," *Semarak International Journal of Innovation in Learning and Education*, vol. 2, pp. 1–24, 2024.
[16] S. Ismail *et al.*, "Kepentingan Aplikasi Digital dalam Pembelajaran Anak Muda Era Industri 4.0 The Importance of Digital Applications in Young Children's Learning Industry Era 4.0," *Semarak International Journal of STEM Education 1, Issue*, vol. 1, pp. 28–38, 2024.
[17] P. Kaur Sidhu, F. Shasha Abdullah, and M. Sirajuddin Jalil, "Awareness and Readiness of Malaysian Generation Z Students towards the Fourth Industrial Revolution (IR4.0)," *Semarak International Journal of STEM Education 1, Issue*, vol. 1, pp. 20–27, 2024.
[18] C. Chi, M. Md Yunus, K. M. Rafiqah Rafiq, H. Hameed, and E. Ediyanto, "A Systematic Review on Multidisciplinary Technological Approaches in Higher Education," 2024.
[19] A. Suh and J. Prophet, "The state of immersive technology research: A literature analysis," *Comput Human Behav*, vol. 86, pp. 77–90, Sep. 2018, doi: 10.1016/j.chb.2018.04.019.
[20] A. Kay and A. Goldberg, "Personal dynamic media," *Computer (Long Beach Calif)*, vol. 10, no. 3, 1977, doi: 10.1109/C-M.1977.217672.
[21] B. G. Moens, "Aesthetic experience in virtual museums: A postphenomenological perspective," *Studies in Digital Heritage*, vol. 2, no. 1. 2018. doi: 10.14434/sdh.v2i1.24468.
[22] J. L. Rubio-Tamayo, M. G. Barrio, and F. G. García, "Immersive environments and virtual reality: Systematic review and advances in communication, interaction and simulation," *Multimodal Technologies and Interaction*, vol. 1, no. 4. MDPI AG, Dec. 01, 2017. doi: 10.3390/mti1040021.
[23] E. Dogan and M. H. Kan, "Bringing heritage sites to life for visitors: Towards a conceptual framework for immersive experience," *Advances in Hospitality and Tourism Research*, vol. 8, no. 1, 2020, doi: 10.30519/ahtr.630783.
[24] J. Vindenes and B. Wasson, "A Postphenomenological Framework for Studying User Experience of Immersive Virtual Reality," *Front Virtual Real*, vol. 2, Apr. 2021, doi: 10.3389/frvir.2021.656423.

[25] M. Zarour and M. Alharbi, "User experience framework that combines aspects, dimensions, and measurement methods," *Cogent Eng*, vol. 4, no. 1, Jan. 2017, doi: 10.1080/23311916.2017.1421006.
[26] T. Kang, M. Chae, E. Seo, M. Kim, and J. Kim, "Deephandsvr: Hand interface using deep learning in immersive virtual reality," *Electronics (Switzerland)*, vol. 9, no. 11, 2020, doi: 10.3390/electronics9111863.
[27] A. Zenner, A. Makhsadov, S. Klingner, D. Liebemann, and A. Krüger, "Immersive Process Model Exploration in Virtual Reality," *IEEE Trans Vis Comput Graph*, vol. 26, no. 5, 2020, doi: 10.1109/TVCG.2020.2973476.
[28] Y. C. Huang, L. N. Li, H. Y. Lee, M. H. E. M. Browning, and C. P. Yu, "Surfing in virtual reality: An application of extended technology acceptance model with flow theory," *Computers in Human Behavior Reports*, vol. 9, Mar. 2023, doi: 10.1016/j.chbr.2022.100252.
[29] I. Brinck, "Empathy, engagement, entrainment: the interaction dynamics of aesthetic experience," *Cogn Process*, vol. 19, no. 2, 2018, doi: 10.1007/s10339-017-0805-x.
[30] F. Galeazzi, "3-D virtual replicas and simulations of the past: 'Real' or 'Fake' representations?," *Curr Anthropol*, vol. 59, no. 3, pp. 268–286, Jun. 2018, doi: 10.1086/697489.
[31] F. Perossini, S. Boi, and M. Capua, "Digital Preservation (challenges, preparedness and reaction)," *IOP Conf Ser Mater Sci Eng*, vol. 949, no. 1, 2020, doi: 10.1088/1757-899x/949/1/012112.
[32] H. Rahaman and B. K. Tan, "Interpreting digital heritage: Considering the end user's perspective," in *New Frontiers - Proceedings of the 15th International Conference on Computer-Aided Architectural Design in Asia, CAADRIA 2010*, 2010, pp. 93–102. doi: 10.52842/conf.caadria.2010.093.
[33] H. Cecotti, "Cultural Heritage in Fully Immersive Virtual Reality," *Virtual Worlds*, vol. 1, no. 1, pp. 82–102, Sep. 2022, doi: 10.3390/virtualworlds1010006.
[34] L. Pujol Tost and E. M. Champion, "Evaluating presence in cultural heritage projects," *International Journal of Heritage Studies*, vol. 18, no. 1, pp. 83–102, Jan. 2012, doi: 10.1080/13527258.2011.577796.
[35] D. Marini, R. Folgieri, D. Gadia, and A. Rizzi, "Virtual reality as a communication process," *Virtual Real*, vol. 16, no. 3, pp. 233–241, Sep. 2012, doi: 10.1007/s10055-011-0200-3.
[36] J. Huggett, "Virtually real or really virtual: Towards a heritage metaverse?," *Studies in Digital Heritage*, vol. 4, no. 1, 2020, doi: 10.14434/sdh.v4i1.26218.
[37] S. C. Noh and A. M. A. Karim, "Design thinking mindset to enhance education 4.0 competitiveness in Malaysia," *International Journal of Evaluation and Research in Education*, vol. 10, no. 2, pp. 494–501, 2021, doi: 10.11591/ijere.v10i2.20988.
[38] D. Checa and A. Bustillo, "A review of immersive virtual reality serious games to enhance learning and training," *Multimed Tools Appl*, vol. 79, no. 9–10, pp. 5501–5527, Mar. 2020, doi: 10.1007/s11042-019-08348-9.
[39] G. Wellner, "Image, Science and Technology: a Post-phenomenological Approach. Entrevista com Don Ihde," *Prometeica - Revista de Filosofía y Ciencias*, no. 17, pp. 107–110, Aug. 2018, doi: 10.24316/prometeica.v0i17.234.
[40] V. Peter-Paul, "Beyond the Human Eye Technological Mediation and Posthuman Visions," *Proceedings of AIAS Conference "Mediated Vision",eds P. J.H. Kockelkoren and P. Kockellkoren. (Veenman Publishers en ARTez Press),* pp. 1–7, 2005.
[41] E. Dogan and M. H. Kan, "Bringing heritage sites to life for visitors: Towards a conceptual framework for immersive experience," *Advances in Hospitality and Tourism Research*, vol. 8, no. 1, 2020, doi: 10.30519/ahtr.630783.
[42] B. Flynn, "Augmented visualisation Designing experience for an interpretative cultural heritage," in *Proceedings of the International Conference on Information Visualisation*, 2008, pp. 447–452. doi: 10.1109/IV.2008.103.
[43] B.-K. Tan and H. Rahaman, "Virtual heritage : Reality and criticism," 2009. [Online]. Available: https://www.researchgate.net/publication/275956482
[44] B. Ramic-Brkic, S. Rizvić, and B. Ramić Brkić, "Cultural Heritage Digitalization in BiH: state-of-the-art review and future trends."
[45] H. K. H. Abd El-Sattar, "A New Plot/Character-Based Interactive System For Story-Based Virtual Reality Applications," *Int J Image Graph*, vol. 10, no. 1, 2010, doi: 10.1142/S021946781000369X.
[46] R. Aylett and S. Louchart, "Towards a narrative theory of virtual reality," *Virtual Real*, vol. 7, no. 1, 2003, doi: 10.1007/s10055-003-0114-9.
[47] Y. Breuleux, B. de Coninck, and S. Therrien, "The World Building Framework for Immersive Storytelling Projects," *SHS Web of Conferences*, vol. 64, 2019, doi: 10.1051/shsconf/20196400003.
[48] F. Garzotto, V. Matarazzo, N. Messina, M. Gelsomini, and C. Riva, "Improving museum accessibility through storytelling in wearable immersive virtual reality," in *Proceedings of the 2018 3rd Digital Heritage International Congress, Digital Heritage 2018 - Held jointly with the 2018 24th International Conference on Virtual Systems and Multimedia, VSMM 2018*, Institute of Electrical and Electronics Engineers Inc., Oct. 2018. doi: 10.1109/DigitalHeritage.2018.8810097.
[49] J. Ibanez, R. Aylett, and R. Ruiz-Rodarte, "Storytelling in virtual environments from a virtual guide perspective," *Virtual Real*, vol. 7, no. 1, pp. 30–42, Dec. 2003, doi: 10.1007/s10055-003-0112-y.

[50] S. Rizvic, D. Boskovic, F. Bruno, B. D. Petriaggi, S. Sljivo, and M. Cozza, "Actors in VR storytelling," Oct. 2020, doi: 10.1109/VS-Games.2019.8864520.
[51] S. Louchart and R. Aylett, "Towards a narrative theory of Virtual Reality," *Virtual Real*, vol. 7, no. 1, 2003.
[52] S. Rizvić, D. Bošković, V. Okanović, I. I. Kihić, I. Prazina, and B. Mijatović, "Time travel to the past of bosnia and herzegovina through virtual and augmented reality," *Applied Sciences (Switzerland)*, vol. 11, no. 8, 2021, doi: 10.3390/app11083711.
[53] H. Rahaman, "Digital heritage interpretation: a conceptual framework," *Digital Creativity*, vol. 29, no. 2–3, pp. 208–234, Jul. 2018, doi: 10.1080/14626268.2018.1511602.
[54] E. J. Ramirez, "Ecological and ethical issues in virtual reality research: A call for increased scrutiny," *Philos Psychol*, vol. 32, no. 2, 2019, doi: 10.1080/09515089.2018.1532073.